Novel Ceramic Membrane for High Temperature Carbon Dioxide Separation

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DE-FG26-00NT40824

09/01/00-8/31/01

Flue gas from coal-burning plants is the major source point for generation of carbon dioxide in the atmosphere. Separation of carbon dioxide from flue gas presents several technical challenges. Many existing technologies suitable for separation of carbon dioxide from industrial streams become cost ineffective for separation of carbon dioxide from flue gas. Microporous inorganic membranes developed recently show good perm-selectivity for carbon dioxide over nitrogen at low temperatures. This selectivity is however lost at temperatures above 300°C due to the specific transport mechanism inherent to the microporous membranes. Therefore, following the strategy employed in development of the inorganic membrane for oxygen and nitrogen separation, we proposed to synthesize a non-porous, dense ceramic membrane for separation of carbon dioxide from flue gas at high temperatures.

In this study, we focus on lithium zirconate as a potential material for making the dense ceramic membranes for carbon dioxide separation. We are investigating several fundamental issues including material synthesis of lithium zirconate, phases and microstructure of lithium zirconate, structure change during sorption/desorption process and mechanism of the carbon dioxide sorption in lithium zirconate. Understanding of these fundamental issues is critical to the design and development of the dense membrane for carbon dioxide separation.

Lithium zirconate powders were prepared from lithium carbonate and zirconium oxide (1:1) by a solid state method at various calcination temperatures. XRD analysis shows that the monoclinic lithium zirconate could be prepared in the calcination temperature range from 850 to 1200°C. Carbon dioxide sorption/desorption properties of the obtained lithium zirconate was examined. Carbon dioxide sorption was hardly observed in the case with pure lithium zirconate powder, due to slow sorption kinetic. However, addition of potassium carbonate and lithium carbonate in the lithium zirconate remarkably improved carbon dioxide sorption properties of the lithium zirconate material. In this case, clear weight increase and decrease were observed during carbon dioxide sorption/desorption process. The value of the weight increases is 20% after 270 min carbon dioxide sorption, corresponding to 85% of the theoretical maximum. The microstructure of the lithium zirconate ceramics before and after sorption of carbon dioxide was studied with the help of TGA, DSC and XRD in order to understand the mechanism of carbon dioxide sorption in the ceramics.

List of Publications/Presentations

No publications and presentation yet

Students Receiving the Support from the Grant

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